The short range repulsive forces were approximated by a hard sphere model. The molecular diameter was chosen so as to give the best agreement between the observed and calculated second virial coefficients in the temperature interval from 300°K to 600°K. The following intermolecular potential was used:

$$V=\begin{cases} \infty \text{ if } R<3.16\text{A}, \\ -(1.37/R^3+3.31/R^5)f(\theta_1,\,\theta_2,\,\phi)-(46.8/R^6+147/R^8)\text{ ev.} \\ \qquad\qquad\qquad\text{if } R>3.16\text{A}. \end{cases}$$

In the computation of the second virial coefficient, the quantum correction due to the exchange gf energy between the translational and rotational motions must be included. This correction was taken into account using Kirkwood's method.[5] Table I shows the results. The measured values for the second virial coefficient are those of Keyes.[6] Better agreement with experiment could probably be obtained if a repulsive potential of the form $A\exp-(R/b)$ were introduced, however this was not considered to be worth while in view of the uncertainty in regard to the estimation of the quadrupole effect.

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Solid Solubility Effect of Metallic Surface Friction

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On improving the "Bowden method,"[1] we have obtained the following temperature dependence of the surface friction coefficient μ for a number of metal pairs.

At first for the pair of the same metal, μ remains nearly constant with temperature θ until it vanishes suddenly at the melting point of the metal.

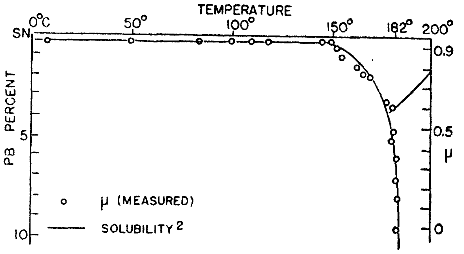

Fig. 1.

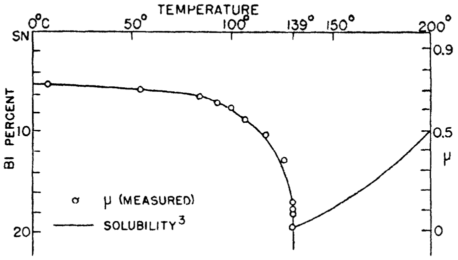

Fig. 2.

For a pair of different metals, we had expected that μ would vanish probably at the lower of the melting points of the component metals. In reality, if the metal pair is of a limited solubility type (a typical example is Sn-Pb, Fig. 1), μ vanishes at neither of the melting points (Sn: 232°C, Pb: 327°C) but at a far lower temperature (182°C), which coincides well with the eutectic point of the binary system. At this temperature a liquid state can be observed along the rubbed trace. This indicates the formation of the eutectic alloy at the friction boundary, and supports Bowden's "local melting theory." Further the full course of the friction coefficient *vs.* temperature curve is so similar to the solubility *vs.* temperature curve on the side of the lower melting point metal in the binary alloy phase-diagram, that an empirical linear relation is found to hold:

$$\mu_\theta=(\alpha_{\text{eutec}}-\alpha_\theta)/k. \tag{1}$$

The quantity k, quite remarkably, is found to have a constant value 10, if α is the solubility of the metal of lower melting point expressed in weight percentage; however, when Bi is a component, k has the exceptional value of 20, when α the solubility of Bi is taken, no matter what the other component may be. A typical example is Bi-Sn, Fig. 2. Data from many metal pairs which were examined are collected in Table I.

Table I. Temperature of vanishing friction coefficient and value of coefficient k in Eq. (1) for several metal pairs of limited solubility.

Metal pair	Lower melt. pt.	Eutec. pt.	Temp. $\mu=0$	k for weight %	k for atomic %
Sn-Pb	232°C	182°C	182°C	10	5.9
Sn-Bi	232	139	139	20	12
Sn-Cd	232	182	182	10	10.4
Sn-Zn	232	199	199	10	10
Sn-Tl	232	170	170	10	10
Bi-Pb	271	125	125	20	20
Bi-Cd	271	148	148	*	*
Bi-Zn	271	254	254	*	*
Tl-Cd	302	204	204	10	10
Cd-Pb	321	247	247	10	10
Cd-Zn	321	255	255	10	16.5
Pb-Sb	327	258	291**	10	16.5

* Solubility is too small to determine the value of k.
** This coincides with the knick point of the solidus line.

For the simple eutectic systems (Sn-Ag, Sn-Al, Sn-Zn, Pb-Ag, and Cd-Bi are examined), the systems with intermetallic compound (Sn-Mg_2Sn, Pb-Mg_2Pb, and $MgZn_2$-$MgZn_5$) and the systems with many intermediate phases (In-Ag, In-Cu, Zn-Ag, Zn-Cu, Cd-Ag, and Sn-Sb), the feature is essentially similar. It is also for pairs with solidified mercury (Hg-Tl, Hg-Rb, and Hg-Te) slightly observable.

We should like to call the correspondence between the friction coefficient and the solid solubility, here observed, the "solid solubility effect" of the metallic surface friction. This effect also gives a guiding suggestion to the determination of the phase-diagram of binary alloy, for example to the existence of the minute solubility or to the preference of the exact solubility curve.

Full results will be published soon in the Journal of the Faculty of Science of Hokkaido University of Japan.

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The Electron Spectrum of Iodine^{131}

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Because of its extensive use in medicine, the radioactivity of iodine 131 is of interest. Several reports have appeared recently[1–5] giving the energies of the gamma-rays of this isotope. Three of these investigations employed electron

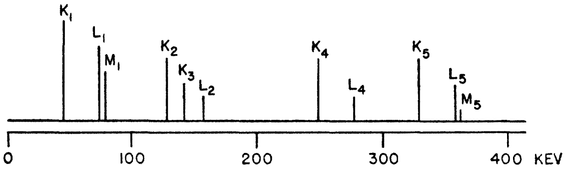

FIG. 1. Energy of the electron lines from iodine 131.

lens spectrometers with their accompanying low resolving power to evaluate the energy of the conversion electrons. J. DuMond and associates[4] have observed the unconverted gamma-rays in a crystal spectrometer and report energies of 80.13, 284.13, and 364.18 kev. We had, by means of photographic spectrometers, observed these and other gamma-rays with good relative precision but, due to the uncertainty in the absolute value of the magnetic field, entertained some doubt of the absolute accuracy. It is of interest to note that our previously published values for the strong higher energy lines were reported[3] as 284.8 and 365.0 kev, values consistently slightly greater than those of DuMond. It is now possible to calibrate the magnetic fields in an absolute manner in terms of DuMond's energies.

The complete electron spectrum as now obtained from carrier-free specimens procured from Oak Ridge is shown in Fig. 1, and the energies are collected in Table I. This shows clearly four electron line sets with energy differences characteristic of xenon. A single additional electron line at 142.5 kev is interpreted as a *K* line. In all, there are five gamma-rays whose energies are 80.1, 163.6, 177.0, 284.1, and 364.2 kev.

TABLE I. The electron spectrum of iodine 131.

Observed line	Identification	Gamma-energy
45.6 kev	K_1	80.1 kev
74.7	L_1	80.1
79.0	M_1	80.1
129.1	K_2	163.6
142.5	K_3	177.0
158.2	L_2	163.6
249.6	K_4	284.1
278.7	L_4	284.1
329.7	K_5	364.2
358.8	L_5	364.2
363.1	M_5	364.2

A higher energy line was observed with less accuracy by absorption in lead. This had been reported by Deutsch as having an energy of 638 kev. It is now possible to propose a satisfactory level scheme incorporating the new lines, as shown in Fig. 2, provided both the lower energy beta-limit and the high energy gamma-ray are less energetic than reported by Deutsch. On observing the curves as presented this would seem to be not impossible.

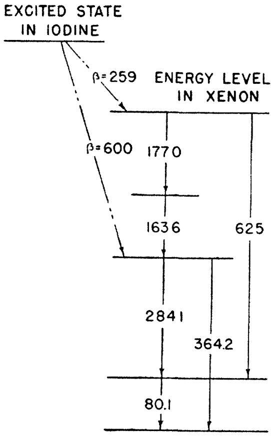

FIG. 2. A possible level scheme associated with iodine 131.

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Microwave Absorption of Some Organic Vapors

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A MICROWAVE spectrograph for the 1.25-cm region has been built. The Hughes-Wilson technique[1] was applied. The klystron is a frequency-modulated 2K33 which radiates in the 22,600–25,700-mc region. Unfortunately, the coverage is not total, as the klystron is of a somewhat deteriorated war-surplus quality. The regions 24320–24270, 22860–22820 plus smaller, scattered regions are generally inaccessible. The gas cell is a 3-m *K*-band wave guide, vacuum-tight sealed by mica windows and placed with the broad side downwards. The modulation electrode is placed on the bottom of the cell, insulated from the guide by paper. It is kept straight by two weights placed outside the cell and connected with the electrode by violin strings, carried vacuum-tight through the mica windows. To ensure that the electrode follows the bottom of the guide, the latter is placed in a slightly curved position. The distance electrode-upper wave guide wall seems to be quite constant judging from the sharpness of e.g., the cos line at 24326 mc. This electrode has the advantage of being easy to place but the cell-electrode capacity is high, which gives rise to trouble in the construction of a stable square-wave generator, desirable as modulator element. So far, a d.c. voltage between 50 and 300 volts, superimposed by a sine wave with amplitude ±40 volts and frequency 0.22–0.24 mc, has been used. The narrow band communication receiver (~2 kc) following the 1N26 crystal is tuned to the frequency of the sine oscillator. The radio output, after passing an RC-filter, is displayed on an oscilloscope screen and simultaneously listened to via a loudspeaker. Signals, indicating absorption, are easily distinguished from the different types of noise in the way they look and sound, and in that they disappear when the sine oscillator is interrupted. Wavelengths are measured by a wave meter of the absorption type calibrated against NH_3, all the lines of which were quoted in literature[2] in the 22600–25700-mc region were observed, as were the lines of BrCN,[3] and cos.[3] Our wave-length measuring technique seems good to ±5 mc, which is rather poor in these days. While a suitable frequency-measuring system is being constructed, we have investigated a number of organic gases to get an impression of the possibilities of the microwave technique.

Organic vapors hitherto investigated are CH_3OH,[4-6] CH_3NH_2,[5] CH_3Cl, CH_3Br, CH_3J,[7] CH_3CN,[8] CH_3NC,[8] CH_3NO_2,[6] and $(CH_2)_2O$.[9,10] More organic vapors were tried by us. In the case of acetaldehyde, acetic acid, dimethyl and diethyl-ether, nitrobenzene, pyridin, anilin, furan, and methyleneiodide, no absorption was found. Our positive results are:

C_6H_5Br (bromobenzene; gas pressure 0.3 mm, Stark d.c. voltage 100) 23742–23690–[22050] mc.

C_2H_5OH (ethyl alcohol; pressure 0.16 mm, d.c. voltage 120) 25069–24385–24369–24295–23605–23555–23148–23081–22820 mc.

$(CH_3)_2CO$ (acetone; pressure 0.19 mm, d.c. voltage 100) 24758–24691–24646–24102–23934–23839–23827–23793–23778–23749–23661–23603–23339–22940–[22560]–[22500]–[22410] mc.